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DISCUSSION AND CORRESPONDENCE

A Note on the Glenoid Fossa

The glenoid fossae are depressions on the basal portion of the temporal bones of the skull. They furnish articular surfaces for the condylar processes of the mandible. If the mandible be considered a lever, these fossae furnish the points of resistance for the fulcrum. Since the textbooks on anatomy agree in the description of the glenoid fossa, its form might be presumed to offer little variation.

Topinard[1] suggests that a complete description of the skull should include the biglenoid diameter, especially since this would furnish the value of the intercondylar width of the mandible.

In 1915 Mr. Francis Knowles published a paper on the Glenoid Fossa in Eskimo skulls[2] in which he pointed out the racial value of this feature. In simia it is shallow, in human, deep. In the Eskimo the fossa is of intermediate depth. This shallowness of the fossa in Eskimo skulls he attributes to the extensive use of the mandible in the chewing of raw flesh for food and of hides preparatory to the tanning. A side to side movement of the jaws such as we have in the simia would help to account for this. Mr. Knowles believes this side to side movement in chewing is indicated by the wearing down of the molars, which has proceeded much further on the inner than on the outer surfaces.[3]

If we are to believe Cabibbe[4] there is considerable variation in the posterior margin of the fossa, the posterior *eminentia articularis* of

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[1] *D'Elements d'Anthropologie Generelle*, 697.

[2] *Anthropological Series of the Canadian Geological Survey*, No. 4, Ottawa, 1915.

[3] May not this unequal depression of the surface of the molar be due to greater use of the inner surfaces, the food more frequently resting there than on the outer? This would tend to pull the molars inward, a result frequently found in the Eskimo skulls. The Indian skulls from the shellmounds around San Francisco bay show this wearing down of the inner surfaces of molars and the turning inward of these teeth. But the glenoid fossa is deep, and the surface area identical with that of the condyle, so that no indication of lateral movement is to be found at this point. The presence of particles of shell in the food of these Indians would account for this unequal wearing down of the teeth, if they came into contact with the inner upper surfaces more frequently than with the outer.

[4] Il pro esso postglenoideo nei cranii di normali, alienati, criminali in rapporto a quello dei varii ordini di mammiferi, *Anatomischer Anzeiger*, Sept. 1901, Vol. 20, pp. 81–96.

English anatomists. Criminals—especially thieves—are said to possess a downward extending tubercle on the external lateral margin about midway between the posterior and anterior margins of the fossa. This downward extending tubercle, like a slowly forming stalactite, is seen also in the feeble-minded, though there it is less developed. In the skulls of imbeciles there is often found, back of the point where this tubercle occurs, a notch or sulcus anterior to the auditory bulla. Dr. Cabibbe has not suggested an explanation of these anomalies in the skulls of criminals and lunatics and we can surmise none.

Mr. Knowles' assumption that muscular or mechanical forces may exert considerable influence on the form of the glenoid fossa is further confirmed by the effect of acromegaly upon its conformation. In 1890 Mr. H. A. Thomson published in the *Journal of Anatomy and Physiology* a description of acromegaly which pertains in part to changes in the glenoid fossa due to excessive mandibular development. The hypertrophy, in the specimen in question, not only affected almost every important facial feature but transformed the lower jaw in a most remarkable manner. It had grown until it had attained a forward projection so great that the lower incisors articulated anteriorly to the upper, thus demanding such an increased muscular pull, along with the larger leverage, as that to which Mr. Knowles calls our attention. Associated with this forward jaw are large condyles and a glenoid fossa nearly circular rather than, as we normally find, markedly transverse in area. The interest in the shape lies in the fact that it seems to have been attained by a wearing down of the anterior margin, the *eminentia articularis.*

This is similar to the change that occurs on the margin of joint-sockets elsewhere in the body when we have an enlargement of the articulating epiphyses or condyles; for example, in the lower border of the femur and the upper border of the tibia; in the lower border of the tibia and the upper surfaces of the astragalus. In the latter instances, however, we generally find the articular surfaces smooth and polished, while in the specimen described by Thomson the floor of the cavity is irregular and rough and we find no trace of new bone in its immediate neighborhood. The change in the glenoid fossa seems, therefore, not attributable to new bony structure; and, not being osteophytic, appears to be the result of mechanical forces, associated with the unusually massive and prominent jaw, and the corresponding lengthening of the leverage. The condyles showed marked increase in transverse diameter and were, moreover, directed forwards and inwards towards the mesial plane of the head—an orientation that would further tend to diminish the elevation of the *eminentia articularis* and give circular form to the glenoid fossa.

Acromegaly is comparatively a recent investigation in anatomy, and, though the literature has grown apace in the last two decades, we have failed to find whether or not the changes recorded by Thomson are usual.[1]

Neither, so far as we can learn, has anyone taken the trouble to test the correctness of Topinard's assumption that the biglenoid diameter is identical with the bicondylar diameter. Our observation of a large number of California Indian skulls, showing signs of considerable muscular mandibular pull, seemed to confirm Topinard's observation, and measurements demonstrated its correctness. With Europeans also, the inner and outer diameters of the condyles correspond respectively to the inner and outer diameters of the glenoid fossa in the specimens which we have measured.

A glance at the skulls of simia show, however, that Topinard's assumption, which, by him, is not applied to any but human skulls, is not true of the anthropoids. This disparity in simia seems to hold irrespective of age, though possibly generally more marked in adults than in the young. The Orang, however, may be an exception, for the disparity may be greater in the young of this species than in adults.

Thus, in an adult gorilla, and in a baboon with canines and third molars appearing, the condyles do not cover the entire glenoid cavity, leaving uncovered portions of both outer and inner surfaces. In a young Orang having the milk teeth, and with sagittal, frontal, parietal, and lamboid sutures still open, there is a similar failure of the condylar surfaces to overlie the glenoid. In the last mentioned an *eminentia articularis* is scarcely observable, while in the former two the fossae are very shallow.

The difference between the articulation of the condyles with the glenoid fossae in human skulls and in those of simia may perhaps best be stated in this way: looking down the outer lateral border of the ascending ramus with the mandible in position and the skull held at arm's length, the glenoid fossa is, in the human, hidden by the condyle, while in the simia it is observable. If, with the skull in this position, we look along the inner line of the ascending ramus, the same differences hold.

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[1] Sollas insists that we must infer distortion in a skull where the condyles fall about ten mm. in front of the glenoid cavities, if the jaw is so placed that upper and lower incisors meet. Presumably he means posthumous distortion. (*Ancient Hunters*, 203–4.)

As such differences are best expressed in measurements we may offer the following results[1] in the accompanying table.

TABLE

	Outer Condylar Diameter	Inner Condylar	Outer Glenoid Fossa	Inner Glenoid Fossa
Baboon (*Papio porcarina*) (adult)	98.5	53	103	40?
" (Last molar appearing)	89	55	93	52
Gibbon (*Hylobates mullerii*)	49	33·5	49	33·5
Simia satyrus				
(Last molars appearing)	87	58	88	56
" " " (adult)	128	67	132	65
" " " (adult)	114	61	118	60
Gorilla (adult)	135	66	138	70
" (adult)	120	68	124	66
Eskimo (adult)	122	82	123	81
" (adult)	114	73	115	72
" (young) (second molar appearing)	87.5	62.5	94?	62
" (adult)(third molar unerupted)	98	70	104?	71

A series of eighteen Orang skulls (male and female) give an average difference of two mm. in the articular surfaces of the glenoid fossa and the condyloid processes in favor of the former. A series of seventeen Eskimo, of which the two quoted are type specimens, give an average difference of one mm., showing that they stand intermediate between the Simiidae and the European, for in the latter the condyle completely covers the fossa. It is interesting to note that the Gibbon measured stands in this respect with the European rather than with the other Simiidae, or the primitive Eskimo. A series of twenty-seven Eskimo skulls from Point Barrow examined as to the shallowness of the glenoid fossa (see Knowles' drawing), gives twelve shallow, twelve medium, three deep, showing that there is considerable variation. The young skulls exhibit the shallowest fossa, giving an extreme outer measurement (see above).

The post-glenoid margin is little developed in insects, more in the herbivorous animals, and most of all, among mammals, in the carnivorous and omnivorous. In the non-ruminants it is absent (wild boar), or but slightly marked (domestic pig). Ruminants show it slightly (giraffe), or markedly (Bovidi). Among the carnivora it is most prominent in the bear, the hyena, and the lion. In marsupials it is present but is only slightly developed.[1]

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[1] It is often difficult to determine the exact location of the inner margin of the fossa, as this frequently slopes off most gradually into the adjoining bony surface, there being scarcely a perceptible line of demarcation.

The exact relation of the form of the fossa to the pressure and movement of the condyle can be determined only after further study. Duckworth[2] insists that the shallowness of the glenoid fossa in the gorilla and in *Hylobates mülleri* is not related to the free lateral movements of the mandible in mastication. "Such a conclusion would be erroneous, for the fact that the canine teeth surpass those adjacent to them in height, favors a single hinge-like movement of the temporo-mandibular joint." The data do not justify Duckworth's inference. The overlapping of the canines in gorilla and hylobates limits the lateral movement of the mandible but does not preclude all lateral movement, unless when the teeth are close shut. This overlapping of the canines may, in fact, directly contribute to a lateral shift in the condyles, as such a shift must result when unequal lateral pressure is brought to bear on the respective canines. Duckworth seems not to have observed that with the shallowness of the fossa goes an increase in area greater than the increase in the condylar surface opposed to it. How this increase in area beyond that of the articulating condylar processes is to be accounted for, unless we suppose a lateral movement in the condyles, has not been suggested.

We have not been able satisfactorily to test this principle in the larger zoölogical world, nor have we been able to learn that the zoölogists have paid any especial attention to the matter. Professor Merriam informs us that the shallow fossa with large surface and low margins has been recognized by paleontologists as characteristic of those extinct species that show evidence of extensive use of the mandible in a side-to-side grinding movement—the sabre-toothed tiger, for example. Thus, as Topinard would say, there appears to be more zoölogical than anthropological significance in the form of the glenoid fossa in human skulls. It is one of many instances in which use and disuse will go far in explaining 'racial' characteristics. The cumulative value of such details may call for a modification of some current theories of physical anthropology, and an insistence that racial features can not be properly understood so long as we treat man as a creature outside of the larger zoölogical world of which, in truth, he is an integral part.

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[1] Cabibbe, *op. cit.*

[2] *Morphology and Anthropology*, I, 173–4, 214, Cambridge Univ. Press, 1915.